

Heatwaves and PM_{2.5}: Sometimes-Surprising Associations with Preterm Birth

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Extreme heat is linked to higher mortality from a variety of causes ranging from heart disease to heat stroke.^{1,2} Climate change is not only raising the global temperatures—with local areas experiencing extreme heatwaves—it may also cause a deterioration in air quality by altering the behavior of primary pollutants and the formation of secondary pollutants.^{3,4} A retrospective cohort study published in *Environmental Health Perspectives* looked at the relationship between fine particulate matter (PM_{2.5}) combined with heatwaves and the risk of preterm birth in Guangzhou, China.⁵

Heat and air pollution have each been independently associated with increases in the risk of preterm birth (fewer than 37 weeks of gestation).^{6,7,8} Although findings have not been conclusive, some past studies showed that extreme heat and air pollution may work synergistically to increase mortality, particularly from cardiovascular and respiratory conditions.^{9,10} However, the combined effects of heat and pollution on premature birth are even less certain. Complications of preterm birth are a leading cause of mortality among children under 5 years of age, especially in developing countries, causing approximately 1 million deaths in 2015.¹¹

Using birth registry data, the authors of the new paper looked at 215,059 singleton live births in Guangzhou that occurred during the warm season (May through October) in 2015, 2016, and

2017. The investigators studied heatwave periods of at least two, three, and four consecutive days above various temperature thresholds ranging from 33°C (91.4°F) to 37°C (98.6°F).

Consistent with past studies, numbers of preterm births rose with heatwave exposure during the final week before birth. When the lowest temperature threshold was used to define a heatwave and the duration was less than 4 days, preterm birth was not increased. However, preterm birth did increase 1.1 times when a 33°C heatwave lasted 4 days. Associations increased with higher temperature thresholds and longer durations, with 1.9 times more preterm births after 3 days of 36.4°C or 2 days of 37°C.

Estimates of the combined effects of PM_{2.5} and less intense heatwaves—which had weak or null associations with preterm birth when PM_{2.5} was low—suggested that preterm birth increased more than expected when both were present, consistent with a synergistic effect. In contrast, when high PM_{2.5} was combined with more intense heatwaves—which were positively associated with preterm birth even when PM_{2.5} was low—the estimated combined effect was additive or slightly lower than expected. This suggests that higher PM_{2.5} did not cause an additional increase in the risk of preterm birth beyond the risk associated with intense heatwaves alone.



The strong positive association between heatwaves and preterm birth increases with heatwave intensity. It is possible that, as the magnitude of the effect of heat increases, the relatively minor added effect of PM_{2.5} doesn't matter—which may explain why a synergistic interaction between high PM_{2.5} and extended hot temperatures seemed to be limited to less intense heatwaves. Image: © iStockphoto/torwai.

The evidence that PM_{2.5} acts synergistically only with less intense heatwaves to increase preterm birth—but not with more intense heatwaves—surprised the authors. Lead author Cunrui Huang, a professor of health policy and management at Sun Yat-sen University, says behavioral adaptations may play some role. For example, he says, on days during less intense heatwaves, pregnant women may not feel the need to take protective actions. However, on extremely hot days, they may be more likely to drink more fluids or use air conditioning. “Such adjustments may offset some of the harmful effects of very intense heatwaves,” Huang says. “More importantly, people tend to reduce outdoor activities during very hot days, thereby potentially reducing their exposure to both heatwaves and PM_{2.5}.”

“[This new research] strengthens the evidence that exposure to heat extremes and PM_{2.5} can trigger preterm birth. The large sample size allowed exploration of different temperature thresholds and of the impact of consecutive numbers of hot days,” says Kristie Ebi, a professor at the University of Washington’s Center for Health and the Global Environment, who was not involved in the study. She notes that heatwaves of a week or longer are not uncommon. “With stronger associations on days three to four,” she says, “it would have been interesting to understand whether the strength of the association continued to increase on days five and beyond.”

The authors treated gestational age as a time-to-event variable and performed a survival analysis to estimate short-term effects. To estimate the true effect of exposure at the week before birth, they controlled for the effects of longer-term gestational PM_{2.5} and temperature exposures through an integrated model strategy. In addition, they took considerable care to test many different definitions of heatwaves. Bin Jalaludin, an epidemiology professor at the University of New South Wales, Australia, says the methodology is very sound. “This is important as there is no international agreement on what constitutes a heatwave,” says Jalaludin, who also was not involved in the study. “With climate change, we anticipate more intense and more frequent heatwaves. Therefore, if these results are corroborated, we also anticipate more preterm births.”

It is never advisable to rely on just one study or a few studies to make policy or practice changes, adds Jalaludin. “It is important to obtain further evidence from regions with different air pollution levels, climatic conditions, and living conditions to corroborate the results from this study,” he says.

As for Huang, he wants to continue and expand this line of research. “We hope to extend the target period to the whole gestation to see if earlier exposure to heatwaves could also affect preterm birth risk,” he says. “In addition, we are conducting a prospective birth

cohort study, where we have collected more detailed information, gestational complications, and also blood samples of pregnant women.” Testing certain biomarkers may shed light on underlying mechanisms for the relationship between heatwaves, PM_{2.5}, and preterm births.

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